ESEARCH PAPER NO. 32 May 1954

A CONDITION GUIDE FOR ASPEN RANGES OF UTAH, NEVADA, SOUTHERN IDAHO, AND WESTERN WYOMING

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Aspen, Populus tremuloides Michx., the most widespread deciduous tree of western United States, is one of the most prominent features of its native, high mountain habitat. Its conspicuous, relatively pure and single-aged stands, vivid green foliage in summer, bright yellow leaves in autumn, and distinctive white trunks at any season--all set it apart from the conifers and shrub communities which may surround it.

In Utah, Nevada, western Wyoming, and Idaho south of the Salmon River,[2/] the area of range dominated by aspen approximates 2,000,000 acres. The lower and upper elevational limits of the type rise from north to south, from approximately 5,500 and 8,000 feet in southern Idaho to 8,000 and 10,000 feet in southern Utah. The type usually occurs between the mountain brush or sagebrush on the lower side and the subalpine conifer on the upper.

The type is an important one in the economy of the region. Since it is one of the largest and most productive of the montane types, it is extensively used as a summer range, both for livestock and big game. It makes a considerable contribution to the regulation of streamflow, is also used for recreation, and furnishes some timber products, principally excelsior.

Although forage production on the aspen ranges throughout the region has been reduced far below its normally high potential, little soil erosion is apparent; and from many observations the indications are that these ranges probably could be more easily restored to their former condition than many of the adjacent ones.

Because of the importance of aspen ranges for grazing, range managers are particularly interested in recognizing condition and trend on them. As a basis for grazing management plans, the range manager must know the productive potential of the type, how near a particular range is to this potential, and whether the range is changing toward or away from it. The purpose of this publication is to furnish a guide that will enable the range manager to determine the condition of most aspen-type ranges in the Intermountain region. A discussion of trend will not be entered into here.

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2/ This area formerly defined the area of responsibility of the Intermountain Forest and Range Experiment Station, which has been enlarged since this was written. This restricted area is meant when "Intermountain region" or "region" is used in the present report.

A general treatment of the subject is presented in "Indicators of Condition and Trend on High Range Watersheds in the Intermountain Region" by Ellison, Croft, and Bailey (3).[3/]

This guide is based on examinations of all degrees of range condition over a 4-year period, 1949 to 1952. The ranges examined varied from some that had been ungrazed for 40 years to others that had been virtually denuded by long-continued overgrazing. Observations were made of species composition of ground cover vegetation, both of the aspen understory and adjacent openings, plant and litter cover, vegetal production, degree of erosion, and evidences of trend.

REVIEW OF LITERATURE

Several range condition and trend guides that consider the aspen type, among others, have previously been prepared for local areas of the Intermountain region. Two have been prepared by the administrative branch of the U. S. Forest Service, one for the Mono division of the Toiyabe National Forest in Nevada (15) and one for the Heise Ranger District of the Targhee National Forest in southeastern Idaho (14). Two such guides have been prepared by U. S. Soil Conservation Service technicians for the Bear Lake (4) and Yellowstone Soil Conservation Districts (10) of eastern Idaho. General guides to condition and trend of mountain range-watersheds of this region have been prepared by Ellison (2) and Ellison, Croft, and Bailey (3).

Sampson's early work in central Utah (9) indicated that moderate cattle use and very light sheep use of aspen ranges resulted in proper use of the aspen reproduction. Julander's investigations in Arizona (6) disclosed that aspen was a key forage species for deer summer range, that maximum allowable utilization of aspen reproduction was 70 to 75 percent, and that degree of utilization of aspen was an indicator of relative deer stocking. However, more recent research revealed that in central Utah, when more preferred forage is available, aspen may not be a reliable key species on deer range, and that often aspen utilization is not a sensitive guide to proper stocking (12). Marston's (7) work on soil protection requirements in northern Utah indicated that about a two-thirds cover of vegetation or litter is necessary to avoid excessive soil loss by summer storms.

CHARACTERISTICS OF THE ASPEN TYPE

Aspen stands vary widely in size. They may occur as islands of trees separated by openings of varying size, or as a more or less continuous forest. The term, aspen type, as used in this publication refers to all these areas. It includes not only the areas overshadowed by aspen, but also the openings in the aspen forest. It does not include areas of aspen mixed with more than 50 percent of conifer trees, however, or more than 50 percent of oak and maple.

3/ Figures in parentheses refer to Literature Cited, page 16.

An important characteristic of the aspen type is its very high production potential. Many sites produce 1,000 to 2,000 pounds per acre air-dry, and some as high as 5,000 pounds, of herbaceous and shrubby vegetation. The evidence at hand indicates that on ranges in good condition, the openings are fully as productive of forbs, grasses, and shrubs as the area beneath the aspen overstory.

Aspen Understory

The normal species composition of the understory, which may contain almost any proportion of grasses, forbs, and brush, varies considerably throughout the region. Although the dominance of a single species--aspen--suggests uniformity, some 300 understory species have been identified on aspen ranges and combinations of these 300 species are almost limitless. Species that are normally constituents of adjacent mountain brush, sagebrush, or lodgepole pine types are found in many aspen stands. Thus, where aspen grows near lodgepole stands, its understory vegetation may be dominated by the common dominant of the lodgepole understory, pinegrass, Calamagrostis rubescens. Although this grass is of low palatability, its dominance may be natural rather than induced by past overgrazing.

For most of the aspen ranges of the Intermountain region, however, the natural, undisturbed understory vegetation appears to have consisted chiefly of a mixture of many species of tall, succulent forbs and grasses. Among these the following were probably conspicuous:

Forbs:

Agastache urticifolia	Mertensia leonardi
Aquilegia coerulea	Osmorhiza occidentalis
Aster engelmanni	Senecio serra
Delphinium barbeyi	Thalictrum fendleri
Heracleum lanatum	Valeriana occidentalis

Grasses and sedges:

Agropyron trachycaulum	Carex spp
Bromus carinatus	Elymus glacus

The commonest shrubs were probably Symphoricarpus spp. and Pachistima myrsinites.

The understory of most aspen range has been greatly altered by years of overgrazing. As the palatable species were eliminated by close, repeated use, the change has been toward dominance by lower growing, more drought-resistant, and less palatable species. Severely depleted ranges are dominated by annuals, ruderals, and unpalatable perennials. These less desirable plants often afford little protection to the soil. Litter cover is lessened as the litter is pulverized and trampled, and the soil may be compacted with an attendant increase in soil erosion. In

time the canopy is opened by the continued destruction of aspen reproduction which may eventually result in conversion to a herbaceous type (fig. 1).

At present only a few ranges in good condition and a number of small scattered areas that have escaped severe grazing because of inaccessibility reveal the true potentiality of the aspen type. On ranges that are improving from a depleted condition, evidence of increase of the more palatable species listed above--Aster, Heracleum, Mertensia, Osmorhiza, Valeriana, grasses, and sedges--is usually to be found. It is important to remember that a mixed composition is desirable and natural for the aspen type. Dominance by a single species or very few species (see fig. 3) is usually a sign of overgrazing.

The aspen type is temporary, ecologically speaking, being brought into prominence by fire. Aspen will in time be succeeded by conifers, usually alpine fir, Engelmann spruce, Douglas-fir, or white fir.

Succession to conifers has a marked influence on site charecteristics. The litter layer becomes deeper and different in character. Less light and moisture reach the lower levels of the stand because of greater interception by the conifer crowns. It is probable that consumptive use of soil moisture is substantially changed, although how it is changed is not yet known. Succession to conifers also results in a considerable lowering of the grazing capacity of the type by changes in species composition of the understory vegetation and lessening of production.

Aspen Openings

In the natural, ungrazed state, differences between the herbaceous vegetation of openings and understory are probably minor. Where material differences are found in species composition, vegetal and litter cover and soil compaction, they are probably related to a tendency for animals to concentrate in the openings. It is probable also that vegetation of the openings recovers more slowly than under the aspen canopy because of greater insolation and higher rate of evaporation.

For these reasons openings in the aspen type are considered the key areas. Key areas are defined as those parts of the range that carry the bulk of the grazing load, that are naturally grazed more heavily by livestock than the range as a whole, or that are particularly liable to damage by grazing and trampling. (Very small areas where livestock concentrate excessively, as on salt grounds, at fence corners, or near permanent water, are not to be considered key areas.) If the key areas can be so managed as to maintain their soil stability and forage productivity, and improve in condition, the less heavily grazed portions of the range and those less susceptible to damage may also be expected to improve.

CONDITION

Range condition has been defined as: "...range health; it is the relative position of a range with regard to a standard set up by

management objectives within the practicable potentialities of the site. Satisfactory condition requires vegetation both sufficiently dense to maintain soil stability and having a considerable proportion of choice forage species. Unsatisfactory condition involves either vegetation so sparse as to permit erosion rates greater than normal, or, if sufficiently dense to prevent erosion, a preponderance of undesirable species" (11).

Criteria of Condition

In this publication the gamut of aspen range condition is arbitrarily divided into five classes: excellent, good, fair, poor, and very poor--based on amount of cover, kind of vegetation, amount of total herbage production, degree of erosion, and presence or absence of aspen reproduction.

Cover

The higher percentages of plant and litter cover are directly associated with better range condition, and the lower percentages of cover with poorer range condition. Cover, as the term is used here, refers to the proportion of ground overshadowed by plants 5 feet or less in height, plus that proportion not overshadowed by plants but covered by litter. When the proportion of bare ground is added to these, the total is 100 percent. Since this concept of cover differs from some others commonly used, it will be well to describe in some detail how it is determined. These proportions are determined by viewing all components vertically, visualizing them as reduced to a flat plane on the ground surface, as if in a vertical photograph. The projection to the ground surface of each living plant part, no matter how small, or of each fragment of dead plant material not already covered by leafage, contributes to the respective totals of plant and litter cover. Similarly the openings between leaves and litter through which bare ground can be seen, no matter how minute these may be individually--and they are usually to be found even with very dense cover--are totaled to give the estimate of the proportion of bare ground. Usually there is a natural tendency to ignore openings where the cover is dense, and to ignore litter when it consists of scattered fragments where the ground is nearly bare, which must be guarded against. Objective training in estimating cover in accordance with this concept is provided by use of the point analyzer (1); such training helps overcome these errors of omission.

Species Composition

Species composition expresses the proportions of the various species of grasses, forbs, and shrubs that constitute the aspen understory or the vegetation of openings. It is determined in the same manner as plant or litter cover, that is, on the basis of projection of foliage. While plant cover is only one of the constituents of ground cover, it is regarded as 100 percent for the purpose of expressing species composition. Thus a certain area may be covered 45 percent by live vegetation, and perhaps 15 percent by litter, with the remainder bare ground, but the 45 percent is considered to be 100 percent of the species composition.

Then each species contributes a percentage toward this total of 100 percent.

For use as indicators the plant species are divided into five groups. It should be understood that these groups are somewhat arbitrary and that the individual species in a group characterizing a certain range condition class are not confined to that class but may also be found in others. Thus annuals may be found in small amounts on aspen range in good condition, and some of the more desirable plants may be found on range in poor condition. Some species may persist for years though conditions are no longer favorable for them; as Rudbeckia may persist as the range recovers from past misuse and Mertensia or Bromus carinatus even under overuse. Also several of the plants of Group 2--Agastache, Agropyron, Bromus, and Elymus--usually make up a considerable portion of the vegetation in excellent condition class, although they are most abundant in good condition class.

The species that are found on range in excellent to good condition, and that are practically absent from range in poor condition are all tall, succulent, highly palatable plants that usually disappear under heavy grazing. These plants, placed in Group 1, are:

Aconitum columbianum
Aster engelmanni
Delphinium spp. (tall)
Heracleum lanatum
Mertensia leonardi
Osmorhiza occidentalis
Polemonium foliosissimum
Valeriana occidentalis

The species most abundant on range in good to fair condition, placed in Group 2, are:

Forbs:

Agastache urticifolia
Aquilegia coerulea
Astragalus convallarius diversifolius
Balsamorhiza sagittata
Castilleja spp.
Crepis acuminata
Erigeron spp.
Galium boreale
Helianthella uniflora
Hackelia floribunda
Hedysarum spp.
Ligusticum porteri
Lupinus spp.
Phacelia heterophylla
Senecio serra
Smilacina stellata
Thalictrum fendleri
Trifolium spp.
Vicia americana
Viguiera multiflora

Grasses:

Agropyron subsecundum
Agropyron trachycaulum
Bromus carinatus
Carex spp.
Elymus glaucus
Festuca idahoensis
Festuca ovina
Hordeum spp.
Koeleria cristata
Melica spp.
Phleum alpinum
Poa spp. (tall)
Stipa columbiana

The species most abundant on range in fair to poor condition, placed in Group 3 (fig. 5), are:

Forbs:

Aster spp. (except A. engelmanni)
Agoseris spp.
Allium spp.
Delphinium spp. (low)
Fragaria spp.
Gentiana spp.
Geranium spp.
Hydrophyllum spp.
Lathyrus spp.
Osmorhiza obtusa
Penstemon spp.
Plantago tweedyi
Polemonium albiflorum
Potentilla spp.
Ranunculus spp.
Rudbeckia occidentalis
Rumex spp.
Senecio spp. (except S. serra)
Wyethia amplexicaulis
Valeriana edulis
Viola spp.

Grasses:

Festuca thurberi
Muhlenbergia montana
Poa spp. (low)
Trisetum spicatum

Shrubs:

Amelanchier spp.
Pachistima myrsinites
Populus tremuloides reproduction
Prunus spp.
Sambucus spp.
Salix spp.
Symphoricarpos spp.

The species most often found on range in very poor condition include mat-formers, those that normally occur on warm, dry sites, ruderals, annuals, and ephemeral species that dry up and so give little protection to the soil, and in general, plants of low palatability. These species (Group 4) are:

Annual species:

Amaranthus retroflexus
Chenopodium album
Collinsia tenella
Collomia linearis
Descurania incisa
Galium bifolium
Gayophytum ramosissimum
Lepidium densiflorum
Madia glomerata
Nemophila breviflora
Orthocarpus tolmiei
Polygonum douglasii

Rhizomatus species:

Achillea lanulosa
Artemisia discolor

Species of warm, dry sites:

Arabis spp.
Eriogonum heracleoides
Gilia aggregata
Stipa lettermani

Ruderal species:

Cirsium spp.
Lactuca scariola
Malva rotundifolia
Oenothera flava
Taraxacum officinale
Tragopogon pratensis

Others:

Artemisia spp. (woody)
Astragalus spp. (except A. convallarius diversifolius)
Chrysothamnus spp.
Frasera speciosa
Helenium hoopesii
Mahonia repens
Pteridium aquilinum
Rosa woodsii
Stellaria jamesiana
Urtica gracilis
Veratrum californicum

Several of the species encountered on aspen range seem to have no relation to any particular range condition, but occur as commonly on better as on poorer ranges. These species, and those for which there is insufficient information for more definite assignment, are included in Group 5:

Forbs:

Corallorrhiza spp.
Epilobium angustifolium
Lithophragma spp.
Scrophularia spp.
Thlaspi glaucum

Grass:

Calamagrostis rubescens

Shrubs:

Ribes spp.
Vaccinium spp.

It is difficult to use Groups 2 and 3 as indicators because their proportions first increase as range condition declines and then decrease as condition becomes poorer. For this reason Group 2 is used as an indicator only in conjunction with Group 1, and then only in the poorer condition classes, and Group 3 is not used in "very poor" condition class.

Aspen Reproduction

The presence or absence of aspen reproduction has long been used as an indicator of range condition. If aspen reproduction was present, the range was considered in satisfactory condition; if absent, in unsatisfactory condition. There are several factors other than grazing, however, that influence reproduction of aspen. It has been commonly observed that dense aspen stands usually produce few sprouts, while open stands usually produce many more. A recent study (13) showed that the presence of herbaceous and shrubby vegetation in and near aspen stands may have a definite effect on reducing aspen reproduction. Also another study (12) indicated that several species are more palatable than aspen sprouts, and the range could be overgrazed from the standpoint of these species without materially affecting the aspen. For these reasons the simple presence or absence of reproduction is not a reliable indicator of range condition. If little reproduction is present, and it can be determined

that its absence is due solely to grazing, then this absence is an indicator of unsatisfactory range condition. If the absence of reproduction is not due to grazing, or abundant reproduction is present, then no particular condition class is indicated.

Production

While there is a tendency for high production to be associated with good range condition and low production with poor range condition, many exceptions will be found. Production in any one condition class, depending on the species composition, often varies as much as 600 to 2,200 pounds (air-dry) per acre. Species of different indicator groups--Agropyron, Bromus, Lathyrus, Rudbeckia, and Sambucus--are particularly productive and may influence total production greatly. For these reasons high total production may be misleading. Only low production is used here as an indicator. If production drops below 850 pounds per acre, condition is considered to be no better than "poor," and if it drops below 500 pounds, condition is indicated as "very poor."

Erosion

Observable evidence of erosion in the aspen type is used as an indicator of poor or very poor range condition. Slight erosion is defined as evidence of erosion that is apparent for only a short time--e.g., rill marks--and often occurs in patches, while marked erosion is defined as permanent evidence--e.g. pedestalled plants, gullies--over a considerable area. If observable traces of erosion are present the range can be no better than poor, but lack of erosion does not in itself indicate any condition class. Aspen understory range particularly may be in unsatisfactory condition with no apparent soil erosion.

A Guide to Condition Classification

In table 1 the five condition classes are set against eight indicators of condition. In appraising condition on a particular area, each indicator is considered in turn and, insofar as it applies, a tentative condition class is derived from it. Under some circumstances different indicators will indicate different tentative classes. When this occurs, the final judgment is the lowest condition class indicated. It is believed that sounder judgment of range condition can be achieved in this way than by "averaging" tentative classes.

Though the openings are usually key areas in the aspen type, it is desirable to make observations in the understory as well. On large areas of continuous aspen forest the key areas may be understory. Furthermore the first signs of range improvement usually show up in the understory, sometimes far in advance of their appearance in the openings. In any event a blanket rule will not do: observations need to be made on each range to determine the key areas.

Table 1.--Guide for use of aspen range condition indicators in the Intermountain region

Indicator	Condition class				
	Excellent	Good	Fair	Poor	Very poor
1. Group 1 species, percent	50-100	25-49	25-100	Less than 25	Less than 25
2. Group 2 species, percent	1/ --	--	25-100	Less than 25	Less than 25
3. Group 3 species, percent	0-10	11-25	26-45	46-100	--
4. Group 4 species, percent	0-5	6-15	16-35	36-54	55-100
5. Cover, percent (vegetation plus litter)	90-100	75-89	55-74	40-54	0-39
6. Presence of aspen reproduction	--	--	--	Absent, due to grazing	Absent, due to grazing
7. Erosion	--	--	--	Slight	Marked
8. Production, lbs. per acre, air-dry	850+	850+	850+	500-850	0-500

1/ Blank indicates that a particular indicator is not used in that condition class

To illustrate the use of the condition guide and its application to key openings as well as to understory, adjacent aspen opening and understory ranges actually encountered in the field during the course of this study will be described (table 2).

Area X

The aspen understory at this site has a very high proportion of Group 1 species, moderate amounts of Group 2 and 3 species, and only a small amount of Group 4. Referring to table 1, it is evident that species of Groups 1 and 4 indicate "excellent" condition while species of Group 3 indicate "good." On this range two-thirds of the ground surface is covered with vegetation and, when litter is combined with this, the ground cover is almost complete, indicating a condition class of "excellent." Since production amounts to almost a ton per acre, no erosion is evident, and some aspen reproduction is present, there is no indication of "poor" or "very poor" condition. In view of the rule of conservative

classification, the final condition class indicated is "good." Figure 2 is a photograph of this site.

Table 2.--Plant composition, cover, and production, degree of erosion, and presence of aspen reproduction in three aspen understory stands and openings adjacent to them.

Indicator	Area X		Area Y		Area Z	
	Understory	Open	Understory	Open	Understory	Open
	Percent		Percent		Percent	
Species Composition						
Group 1						
Delphinium barbeyi	1	-	-	-	-	-
Heracleum lanatum	40	7	-	-	-	-
Mertensia leonardi	6	20	-	-	-	-
Osmorhiza occidentalis	7	12	-	-	-	-
Polemonium foliosissimum	2	-	-	-	-	-
Total	56	39	-	-	-	-
Group 2						
Agastache urticifolia	3	7	-	-	-	-
Agropyron trachycaulum	T	T	2	3	-	-
Bromus carinatus	T	26	3	3	3	2
Carex spp.	-	-	2	2	-	-
Erigeron speciosus	-	-	13	9	-	-
Galium boreale	-	-	-	4	-	-
Lupinus spp.	-	-	7	-	-	-
Senecio serra	-	-	-	1	-	-
Smilacina stellata	-	-	T	1	-	-
Thalictrum fendleri	6	2	T	5	-	-
Stipa columbiana	-	-	2	3	-	-
Vicia americana	1	6	3	T	3	2
Viguiera multiflora	-	2	-	1	-	-
Total	10	43	34	33	6	4
Group 3						
Agoseris pumila	-	-	T	1	-	-
Geranium spp.	-	-	5	12	4	-
Lathyrus leucanthus	2	1	-	-	T	-
Osmorhiza obtusa	1	T	T	-	5	T
Penstemon spp.	-	-	3	23	-	-
Potentilla spp.	-	-	T	2	-	-
Rudbeckia occidentalis	-	-	30	6	8	28
Rumex mexicanus	-	-	-	-	-	4
Sambucus spp.	T	13	-	-	-	-
Symphoricarpos spp.	16	-	T	T	41	1
Poa pratensis	-	-	2	1	T	5
Viola spp.	3	-	-	-	6	8
Total	22	14	42	45	64	46

Table 2. (Continued)

Indicator	Area X		Area Y		Area Z	
	Understory	Open	Understory	Open	Understory	Open
	Percent		Percent		Percent	
Group 4						
Achillea lanulosa	-	-	3	3	T	T
Artemisia discolor	-	T	-	5	-	-
Chenopodium album	-	1	T	-	1	4
Collomia linearis	-	T	4	2	2	7
Galium bifolium	T	T	2	-	2	2
Helenium hoopesii	-	-	-	-	T	3
Polygonum douglasii	-	-	T	-	T	4
Stellaria jamesiana	2	1	T	2	2	2
Taraxacum officinale	T	T	14	7	20	26
Total	2	2	23	19	27	48
Group 5	8	-	-	-	T	-
Cover						
Vegetation	68	76	57	54	44	30
Litter	26	15	26	26	27	20
Total	94	91	83	80	71	50
Production (lbs. per acre, air-dry)	1,960	4,150	1,200	1,850	1,480	670
Degree of erosion	None	None	None	None	None	None
Presence of aspen reproduction	Present in moderate amount	--	Present in moderate amount	--	Absent due to grazing	--

Most of the species of the nearby openings are about evenly divided between Groups 1 and 2, with a small amount of Group 3 species and almost none of Group 4. The proportions of both Group 1 and 3 indicate "good," and of Group 4 "excellent," condition. The high total cover also indicates "excellent" condition. Again, the factors of production and erosion suggest that condition is neither "poor" nor "very poor." The final condition class indicated, with the choice between "excellent" and "good," is "good." Figure 4 shows an aspen opening in good condition.

Area Y

A large proportion of the species of the understory stand here fall in Groups 2 and 3, with a smaller amount of Group 4 and no Group 1 species present. The percentage figures in table 1 for these indicators

place the stand tentatively in "fair" condition and the high total cover in "good" condition. Since production is above 850 pounds per acre, aspen reproduction is present in moderate amount, and no erosion is evident, condition is probably neither "poor" nor "very poor." The conclusion, then, based on the lowest tentative condition class indicated, is that this understory range is in "fair" condition.

The species composition of the opening is very similar to that of the understory, but includes a slightly smaller proportion of Group 4 species. The composition percentages indicate "fair" condition. The total cover of this opening also is very similar to that of the adjacent aspen understory stand, and indicates "good." As with the understory stand, production is great enough, and erosion inconspicuous enough, to keep this opening out of the "poor" condition class. Adopting the lowest tentative value, this opening is concluded to be in "fair" condition.

A comparison of the opening and understory stand here reveals very little difference, except a somewhat greater production in the opening. Figures 5 and 6 are photographs of these sites.

Area Z

The indicator species of the understory stand fall most in Groups 3 and 4, very few in Group 2, and none in Group 1. The proportion of Group 3 species indicates "poor," and of Group 4, "fair" condition. As there is less than 25 percent of species in Groups 1 and 2, "poor" or worse is indicated. The almost three-quarters total cover indicates "fair" condition. There is fairly high production, and no evident erosion on the site, indicating neither "poor" nor "very poor." The absence of aspen reproduction here, which from the evidence of utilization is known to be due to grazing, indicates "poor" condition at most. Although several of the factors indicate "fair" condition, the lowest class indicated--on the basis of the proportions of Group 1, 2, and 3 species and the absence of aspen reproduction--is "poor," and this should be the judgment for this aspen understory range.

The opening includes an even higher percentage of Group 4 species than the understory. Both because of the scarcity of Group 1 and Group 2 species and because of the abundance of Group 3 and 4 species, this stand is rated tentatively as "poor." About one-third of the ground surface is covered by foliage, and litter between the plants is abundant enough to bring the total ground cover up to 50 percent, indicating "poor" condition. Production on this site, which is only half as great as on the nearby understory site, likewise rates "poor." The fact that no evidence of erosion was noted probably relates to the fact that no torrential storms had occurred during the summer in which the site was examined. All the indicators point to the conclusion that the final rating here is "poor." Figures 7 and 8 show aspen understory and an aspen opening in poor condition.

Procedure in Judging Range Condition

Because it is difficult to reconstruct vegetation accurately after even moderate utilization, and almost impossible after heavy, the best time to make the inventory is necessarily after vegetation has reached full growth but before the area is grazed, or at least before grazing has materially obscured species composition. However, since the primary reason for the use of plant cover as an indicator of condition is its soil-protective function, and since cover is naturally least at the end of the grazing season, provision should be made to examine the range at a later date also, possibly in connection with observations on utilization, to note how fully vegetation is permitted to protect the soil.

In judging range condition the range manager must select an area for sampling which is reasonably representative of the grazing unit to be judged. Usually an open area within the aspen stand, or an opening at its edge, will be selected as the key area. Cover, plant composition, erosion, indicators of trends, and sometimes production, are to be observed.

To make the observations, a series of small plots is laid out along a transect in the key area. The plots may be spaced at mechanical intervals by pacing or chaining, and may be marked to aid in relocation. In any event the individual plots should not be consciously selected.

The plots should be small enough to be taken in at a glance--a square or circular plot of 9.6 square feet is a convenient size for determining both cover and production. A central hub can be used with radius rods to define a circular plot, four willow sticks can be used to outline a square plot, or a wire hoop can be used.

Ordinarily 20 plots will give a reliable estimate of cover, although in some instances 10 may be enough. The same number, at least, will be needed for estimates of production, if such estimates are to be made. Twenty plots will ordinarily give a good idea as to the proportions of the major species in the stand, but they must be supplemented by observations on the stand as a whole for scarce species and for indicators of erosion and of vegetal trend. The variations in results between plots, and the extent to which the average becomes more stable as plots are added, are the best guides to the number of plots needed in each case.

In estimating cover, as already pointed out, care should be taken to prevent bias so that no one of the elements of bare ground, litter, and living plant material will be favored over others. The observer must balance these three values in his mind as he looks down. His mental processes are fluid as he considers them, and may be something like this: "There is a lot of bare ground on this plot--say 50 percent. There is more leafage than litter--say 30 percent leafage and 20 percent litter. No, when one considers the scattered grass stems on that seemingly bare area, litter should come up to about the same as leafage--make them 30 and 30. Then we must bring bare ground down to 40 percent. Forty, 30 and 30--yes: there's about a third more bare ground than either

leafage or litter, those two are about equal, and together they cover about half as much surface again as the bare ground." Such estimates, after a little practice, can be made rapidly, although one must be alert continually against bias, either in favor of vegetation, bare ground, or litter. If bias can be minimized, a sounder average will be obtained from approximate estimates on many plots than from very precise estimates on only a few plots.

On these same plots, estimates of vegetal composition should be made for all species. Then percent composition for each plot can be balanced in the observer's mind, just as cover values are, to arrive at a total of 100 percent. The names of other species having indicator value encountered off the plots should also be listed, but no percentages are assigned to them.

When all the plots have been examined, the observer averages the percentages for the abundant species, and these averages provide a basis for the estimate of percentage composition of these species in the stand as a whole. Those species that make up less than half of one percent are marked "T" for "trace," and often when such species are numerous, a percentage must be assigned to the total of "T's." After arriving at these percentage figures it is advisable to walk back through the stand, weighing and judging them by simple observation. If the estimates are obviously wrong in any respect, it will be necessary to correct them by supplementing the plots with another series.

Observations on erosion should not be confined to the sample plots. One must be alert over the entire range to observe such indicators as bare areas, trampling displacement, pedestalling of grasses, rill marks, blowouts, and gullies, active or healed. Similarly, observations on vegetal trend must extend beyond the sample plots. Indicators to be watched for particularly are age-class distributions, accessibility of palatable species, hedging of shrubs, and excessive utilization of aspen reproduction. These indicators of condition and trend are described elsewhere (3).

Insofar as using this guide is concerned, there is no need to estimate production unless one wishes to distinguish "fair" from "poor," or "poor" from "very poor" condition. Indeed, although estimates of production are desirable, and are sometimes of great help in arriving at decisions about grazing capacity, it cannot be said categorically that they are essential.

An appraisal of production may be made in one of two ways, either by clipping all the herbage from carefully measured plots and weighing, or by estimating weight after intensive training in weight estimation (5, 8). With either, the work should be done when the vegetation is at the height of its development, preferably before utilization has taken place. If some vegetation has been utilized, an estimate of the amount removed needs to be added to the production values. In either case, too, samples of the vegetation, preferably of each species, must be air-dried to provide correction for moisture content.

Finally, a word should be said about records. Much work is wasted because the observer was in too great a hurry to write out a full account of what he saw. The information he collects should be neatly recorded, fully labeled, with dates, names, places, and units of measurement explained, and carefully preserved, so that the facts can be reconstructed at a later time, either by himself or someone else. The study areas should be permanently marked in the field and described in the notes so that they can be relocated easily. One of the best ways of describing locations is by marking them on a map, if a map of 2 inches to the mile or larger scale is available. The individual plots need not be permanently marked, although if they can be, so much the better. If they are not marked, the direction of the transect line along which they are laid should be given, and its limits should be stated: this will insure sampling the same area on later visits.

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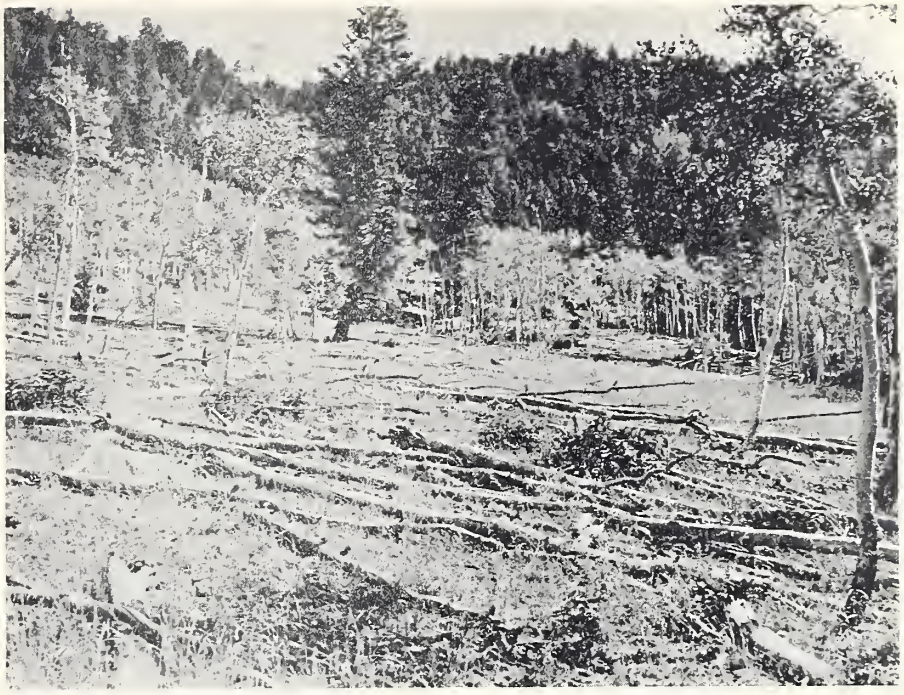

Fig. 1. Conversion of an aspen type to grassland by overgrazing. Sheep grazing on this poor condition aspen area is so heavy that vegetative aspen reproduction is unable to "get away." The older trees are dying, probably of disease, and since no trees are replacing them the stand is doomed to extinction unless grazing pressure is reduced.

Fig. 2. A virtually undisturbed aspen understory site. A dense ground cover, large percentage of palatable forbs, no undesirable plants, no accelerated erosion, and high production combine to indicate one of the most productive sites in the aspen type. This site is classified in good condition, verging on excellent.

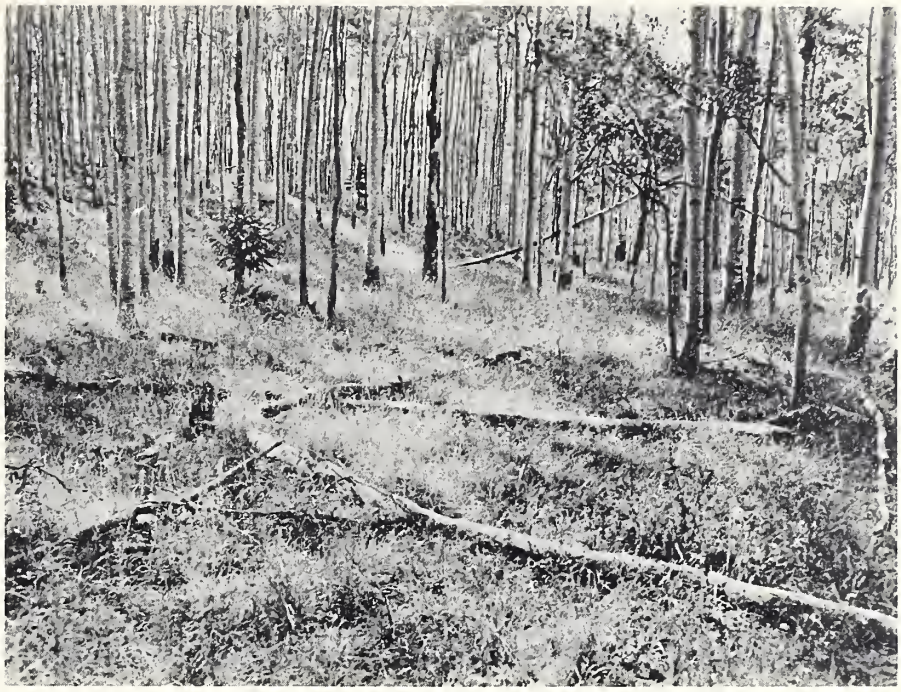

Fig. 3. This grass understory in an aspen stand has been regarded as a model aspen type. Actually in only fair condition, it is a product of class overgrazing by sheep with the elimination of desirable forbs and aspen reproduction.

Fig. 4. A small, good-condition opening in the aspen type. This opening combines a high ground cover of palatable plants with a small percentage of undesirable plants, high production, and no erosion. Note Heracleum lanatum flower heads. Compare this picture with Fig. 2 and note small differences between good condition aspen understory and opening sites.

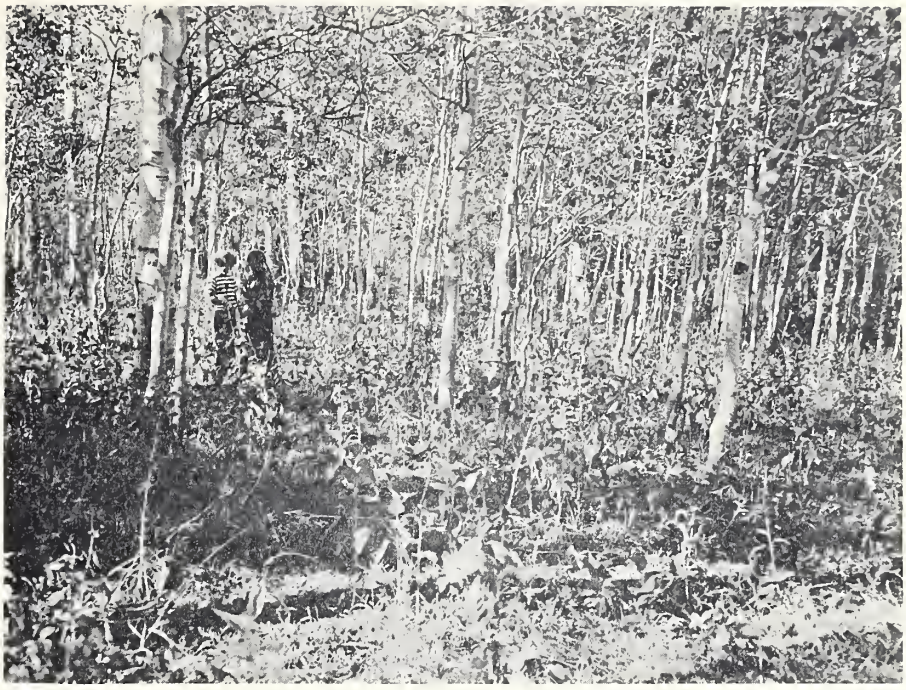

Fig. 5. An aspen understory site. This range is heavily used by cattle and will be gone over by sheep later in season. The ground cover of 57 percent vegetation and 26 percent litter, and high proportion of mountain brome place this site in fair condition.

Fig. 6. An aspen opening 25 yards east of site pictured in Fig. 5. This site likewise is in fair condition. It is described here under Area Y, opening.

Fig. 7. An aspen understory stand in very poor condition. The scanty vegetal ground cover, high proportion of annuals, low production, and lack of aspen reproduction combine to form one of the poorest aspen range sites in the aspen type.

Fig. 8. An aspen opening in very poor condition. This opening is dominated by niggerhead (Rudbeckia), dandelion, and annuals, with extremely low ground cover and production. The adjacent aspen understory, while consisting of much more vegetation than that shown in Fig. 7, is still in very poor condition. Aspen reproduction is entirely utilized each year.